Introduction

Restorative interventions are frequently preferred as augmentative and alternative communication (AAC) interventions are thought to impede neural recovery (Pulvermuller & Berthier, 2008; Weissling & Prentice, 2010). But, clinical observations suggest AAC interventions may improve aphasia (Dietz, Weissling, Griffith, & McKelvey, 2012). The purpose of this study was to compare the influence of a novel AAC and traditional restorative (TR) intervention on linguistic recovery and neural reorganization.

Method

Research Design

We employed a pre-post treatment design; treatment groups were matched for aphasia type.

Participants

People with aphasia. To date 12 people (target N = 14) with chronic aphasia (4 with nonfluent and 2 with fluent aphasia per group) were enrolled. Table 1 provides a summary of the demographic for all participants and Figure 1 displays the lesion overlap of the participants analyzed at the time of submission (001-008).

Healthy Controls. 8 healthy controls matched for handedness, age, gender, and education with participants 001-008 were enrolled (total target = 14).

Materials & Procedures

Behavioral language assessment. The *Western Aphasia Battery-Revised (WAB-R) (Kertesz, 2007)* was administered to calculate the participants' aphasia type and severity.

AAC Equipment and software. The researchers used the Visual Scene Displays software on the DynaVox VMax™. Three digital video cameras captured facial expressions, gestures, written/drawn communication, and the screen of the DynaVox VMax™ during the narrative retell.

Narrative development & retell sessions. Three personal narratives were co-constructed with each participant (Dietz et al., 2006). When applicable, one story was used during the AAC intervention. The remaining two narratives were randomly assigned to be retold in either the "No AAC" or the "With AAC" condition. The participants retold all three personal narratives to a single listener.

Functional Magnetic Resonance Imaging (fMRI). Images were acquired using a Philips 3T Achieva scanner using a sparse acquisition approach (TR = 2000msec, 3 repetitions

per trial, voxel size 4 x 4 x 5 mm, see Schmithorst et al., 2004). High-resolution (voxel size 1 mm isotropic) T1-weighted anatomical images were also obtained.

fMRI tasks. The participants completed a verb generation task, which required participants to listen to pre-recorded nouns (e.g., cookie) and to respond by verbally producing associated verbs (e.g., bake), thinking of associate verbs (covert generation) or repeating the noun (Allendorfer, Lindsell, Siegel, Banks, Vannest, Holland, Szaflarski, 2012).

Treatment. The AAC treatment and TR intervention occurred one hour/day, three times weekly, across four weeks.

AAC intervention. The AAC Treatment included four steps: (1) familiarizing the participant with the device, (2) practicing narrative retell with clinician modeling, (3) practicing narrative retell with no clinician shaping; work on being conversational, (4) retelling their story to a naïve listener, with cueing from clinician. A sampling of 25% of the sessions revealed 97% treatment fidelity.

TR intervention. Standard care was provided by a certified speech-language pathologist, who was not a part of the study team. The clinician reviewed the patients' assessment battery to determine restorative-based linguistic goals.

Behavioral Data Analysis

We analyzed transcribed narratives using the Systematic Analysis of Language Transcripts (SALT). The following measures were calculated: different words (dWords), correct information units (CIUs) (Brookshire & Nicolas, 1993), and CIUs per minute. Once enrollment is complete, descriptive statistics will be computed and effect sizes derived. Paired t-tests or Wilcoxon-sign rank test will be used to assess the statistical significance of pre- and post-treatment between group differences on these measures.

fMRI Data Analysis

Lesions were masked using The Oxford fMRIB software library (FSL) which was further used to mask the lesions, perform spatial normalization, apply motion correction, and spatial smoothing. A general linear model was used to determine significant activation related to overt verb generation versus overt repetition in the healthy controls. The left region of interest (ROI) was determined using healthy controls and was mirrored to the right side of the brain in MNI space (see Figure 2). Once enrollment is complete, group activation maps will be generated to compare the pre- and post-treatment activation patterns. The lateralization index (LI) was calculated by counting the activated voxels above the median Z score within the ROI and applying the following formula: 100 * (Left voxels - Right voxels) ÷ (Left voxels + Right voxels). Correlation with behavioral testing and discourse measures will also be calculated.

Results

Ten participants have completed intervention (AAC = 5; TR = 5); pre- and post-treatment

discourse analyses have been completed on participants 001-009 and neuroimaging analyses for 001-008; these findings are summarized below. Data analysis is underway for participant 10; participants 11 and 12 begin treatment on 1/20/14. We anticipate completion of data collection and analyses by 4/30/14. Pre- and post-treatment behavioral and neuroimaging data for 14 participants will be presented at the conference.

Preliminary Findings

Since the data set is incomplete, we only report subject level changes in this proposal. We will complete the statistical analyses described above for the conference.

Behavioral testing. Two participants from each group improved by 2 or more points on the *WAB-R AQ*. The largest gains (i.e., 4 points or greater) were observed in 3 participants in the AAC group (001, 004, and 009) and 1 in the TR group (007). Participant 001 evolved from Global to Broca's aphasia following the AAC intervention (see Table 2).

TREATED NARRATIVE WITH AAC

Two of the 4 participants who received AAC therapy (001, 004) made numerical increases on number of dWords, CIUs, and CIUs/minute produced.

UNTREATED NARRATIVE WITH AAC

One participant in each group, 001 (AAC) and 003 (TR) produced an increased number of dwords, CIUs, and CIUs/minute.

UNTREATED NARRATIVE—NO AAC

One participant in the TR group (006) exhibited numerical increases in dWords, CIUs, and CIUs/minute.

Table 3 summarizes subject level performance, pre- and post-treatment during their retell of the treated narrative with AAC, untreated narrative with AAC, and the untreated narrative without AAC, respectively.

NEUROIMAGING

Lesion voxel count in ROI. Five participants (001, 002, 004, 006, 008) exhibited relatively high numbers of voxels in the ROI. Two participants (005, 007) exhibited a relatively small number of voxels in the ROI. One participant (003) did not have any lesioned tissue in the ROI (see Figure 3).

LI. Pre-treatment, LIs were largely right lateralized or bilateral; 003 was the exception, demonstrating right LI (-.98). Six of eight participants demonstrated a leftward shift in activation post-treatment, including two of the three (001, 004) who received AAC treatment (see Figure 4).

Discussion

These findings are preliminary and part of a larger study. As such, the results can only be

discussed at the subject level. The findings from the first few participants to complete the AAC treatment suggest that the novel AAC intervention may hold promise for promoting language recovery on behavioral and neuroimaging measures, for at least some people with aphasia. However, carryover to untreated stories was variable. This suggests that instruction needs to be adapted to facilitate generalization to untrained tasks (e.g., home practice program). Also, the participants exhibited variable lesion sizes (and locations), which may play a role in the extent and type of recovery demonstrated (e.g., left vs. right LI on post-treatment testing). Upon completion, this study will shed light on the role of AAC in the aphasia rehabilitation process and help guide development of more efficient interventions.

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Table 1

Participants demographic and language measures at time of study enrollment

	Treatment Group	Gender	Ethnicity	Age	MPO	Education	Aphasia Type	WAB-R AQ
001	AAC	F	Caucasian	56	63	Some College	Global	36.90
002	AAC	M	Caucasian	60	81	Bachelor's	Broca's	68.60
003	TR	F	African American	57	30	Bachelor's	Anomic	89.20
004	AAC	F	Caucasian	46	113	Bachelor's	Broca's	48.90
005	TR	F	Caucasian	60	95	Some College	Conduction	74.00
006	TR	M	Caucasian	57	63	Master's	TCM	62.90
007	TR	M	Caucasian	45	59	High School	Broca's	55.50
008	TR	M	Caucasian	70	60	Bachelor's	Broca's	61.60
009	AAC	F	Caucasian	62	168	Bachelor's	Conduction	70.80
010	AAC	F	Caucasian	56	13	Bachelor's	Broca's	23.40
011	AAC	F	African American	56	41	High School	Anomic	80.60
012	TR	M	Caucasian	65	35	Bachelor's	Broca's	40.90
013	TBD	--	--	--	--	--	--	--
014	TBD	--	--	--	--	--	--	--

Note. [a]WAB-R AQ = Western Aphasia Battery-Revised Aphasia Quotient, maximum score = 100, [b]TCM = Transcortical Motor Aphasia, [c] Concomitant apraxia of speech

Table 2

Pre- to post-treatment changes in WAB-R AQ score and aphasia type.

	Treatment Group	Pre-Treatment Aphasia Type	Post-Treatment Aphasia Type	Pre-Treatment WAB-R AQ[a]	Post-Treatment WAB-R AQ[a]
001[d]	AAC	Global	Broca's	36.90	52.30
002[c]	AAC	Broca's	Broca's	68.60	67.60
003	TR	Anomic	Anomic	89.20	91.20
004[c]	AAC	Broca's	Broca's	48.90	53.60
005	TR	Conduction	Conduction	74.00	74.70
006	TR	TCM[b]	TCM[b]	62.90	61.10
007	TR	Broca's	Broca's	55.50	60.90
008[c]	TR	Broca's	Broca's	61.60	61.80
009	AAC	Conduction	Conduction	70.80	74.80
010	AAC	Broca's	Broca's	23.40	22.40
011	AAC	Anomic	--	80.96	---
012	TR	Broca's	--	40.90	--
013	AAC	--	--	--	--
014	TR	--	--	--	--

Note. [a]WAB-R AQ = Western Aphasia Battery-Revised Aphasia Quotient, maximum score = 100, [b]TCM = Transcortical Motor Aphasia, [c] Concomitant apraxia of speech, [d]Aphasia evolved to different type

Table 3

Pre- to post-treatment changes in dWords, CIUs, and CIUs/minute across all three narrative retells

	Treated Retell with AAC					
	dWords		**%CIUs**		**CIUs/Minute**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
001	34	58	24.26	49.59	3.00	2.63
002	118	110	53.05	57.42	3.10	3.44
003	NA	NA	NA	NA	NA	NA
004	48	62	56.62	71.57	0	4.20
005	NA	NA	NA	NA	NA	NA
006	NA	NA	NA	NA	NA	NA
007	NA	NA	NA	NA	NA	NA
008	NA	NA	NA	NA	NA	NA
009	117	122	44.26	40.28	7.44	6.71
010	123	--	12.39	--	2.07	--
011	--	--	--	--	--	--
012	--	--	--	--	--	--
013	--	--	--	--	--	--
014	--	--	--	--	--	--
	Untreated Retell without AAC					
	dWords		**%CIUs**		**CIUs/Minute**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
001	19	48	37.14	43.14	0	3.33
002	134	112	43.71	42.86	3.00	1.92
004	49	42	63.75	61.11	3.00	4.00
003	144	172	57.40	60.33	9.57	10.06
005	142	134	67.11	61.69	8.50	7.33
006	80	50	40.51	36.51	2.53	2.30
007	128	125	45.50	30.33	3.04	2.09
008	59	63	65.59	58.93	6.29	4.90
009	119	121	45.09	42.62	7.52	7.10
010	126	--	10.56	--	1.76	--
011	--	--	--	--	--	--

012	--	--	--	--	--	--
013	--	--	--	--	--	--
014	--	--	--	--	--	--

Untreated Narrative Retell Without AAC

	dWords[a]		**%CIUs[b]**		**CIUs/Minute**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
001	56	44	19.84	37.59	4.17	8.33
002	95	105	58.65	25.71	23.17	10.50
003	145	167	58.03	57.75	53.00	56.50
004	31	47	43.33	36.90	4.33	5.17
005	149	123	67.00	69.53	44.367	32.33
006	49	54	25.00	30.60	10.17	13.67
007	120	114	34.31	29.63	19.50	18.68
008	48	35	51.95	47.37	6.67	4.50
009	110	132	48.03	39.90	8.05	6.65
010	113	---	18.63	--	3.11	--
011	--	--	--	--	--	--
012	--	--	--	--	--	--
013	--	--	--	--	--	--
014	--	--	--	--	--	--

Note. [a] dWords = Number of different words produced, , [b]CIU = Correct Information Units

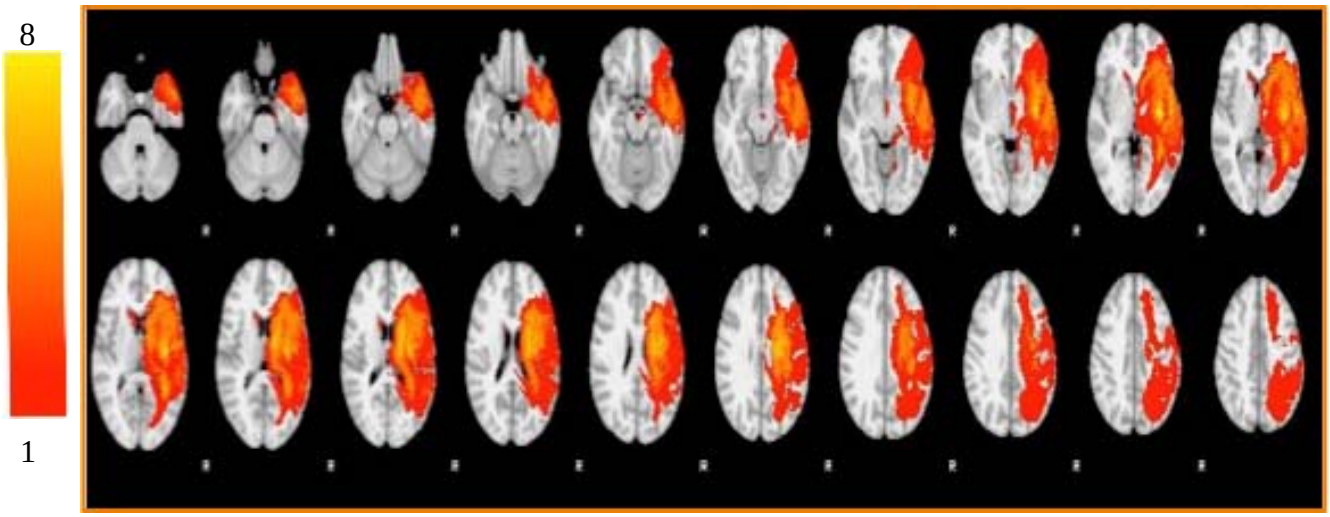

Figure 1. Lesion overlap in the first 8 participants

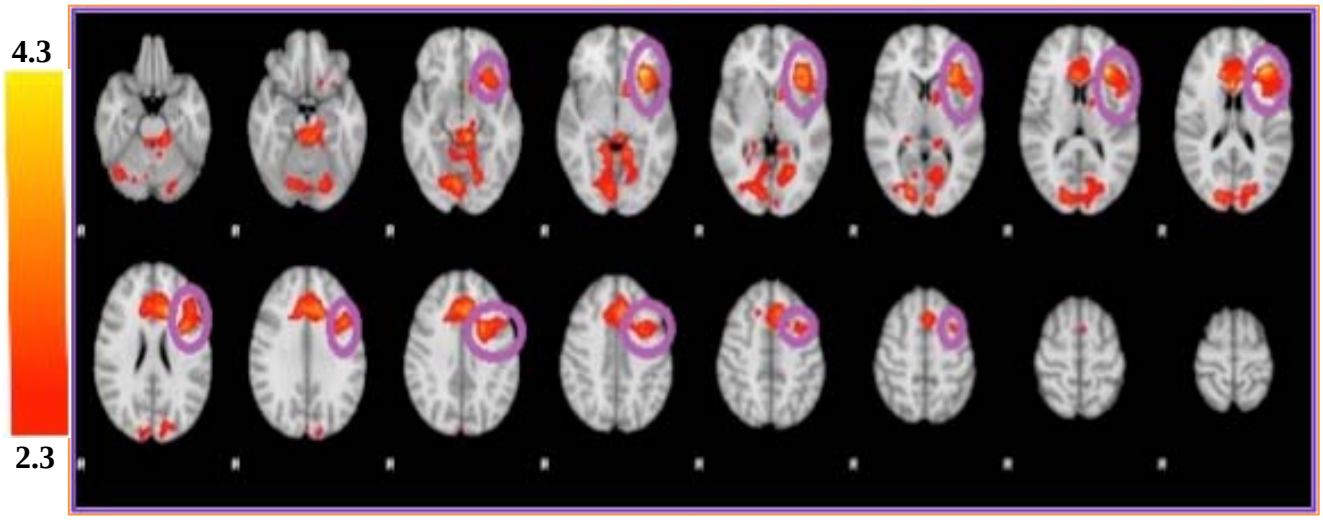

Figure 2. Region of interest (ROI) on the verb task (overt verb generation > repetition) in age-, gender-, education-matched healthy controls matched for handedness, age, gender, and education.

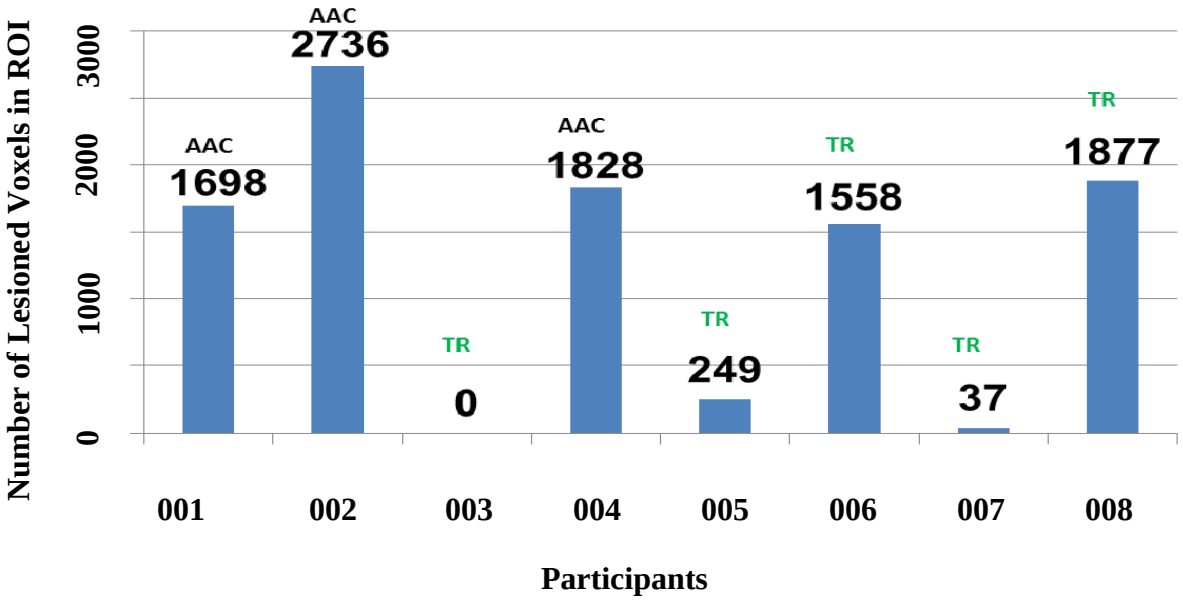

Figure 3. Lesion voxel count in the ROI for the 001-008.

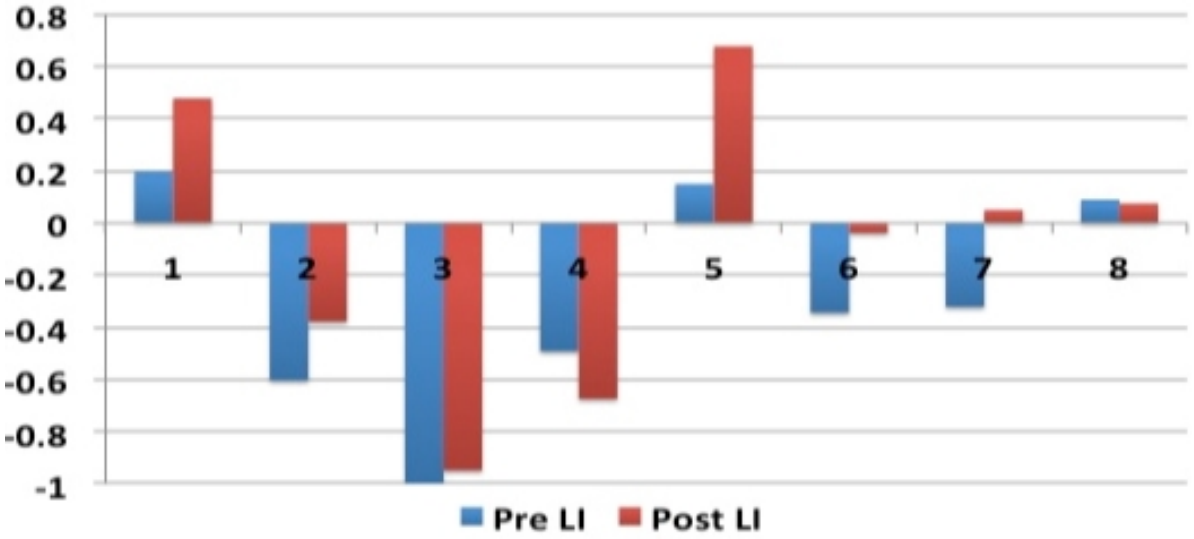

Figure 4. LI values for participants 001-008, pre- and post-treatment; where left laterality = +1.0 and right laterality = -1.0.